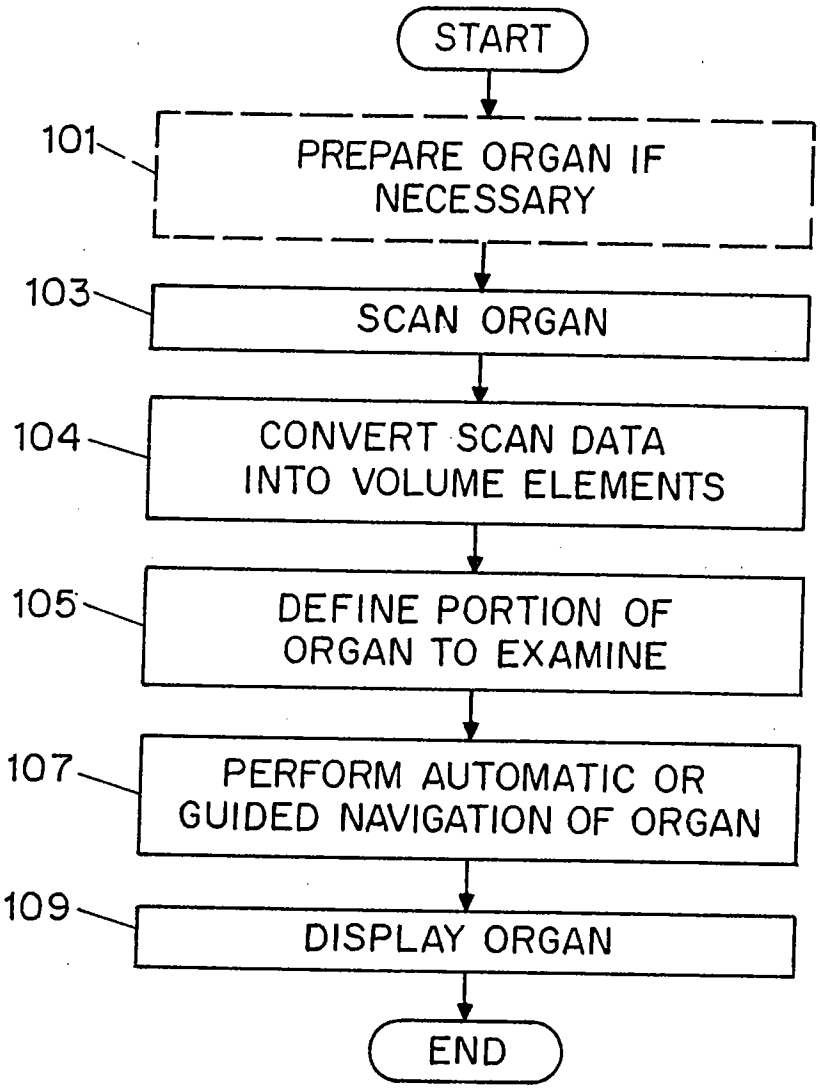
START
101
PREPARE ORGAN IF NECESSARY
103
SCAN ORGAN
104
CONVERT SCAN DATA INTO VOLUME ELEMENTS
105
DEFINE PORTION OF ORGAN TO EXAMINE
107
PERFORM AUTOMATIC OR GUIDED NAVIGATION OF ORGAN
109
DISPLAY ORGAN
END

FIG. 1

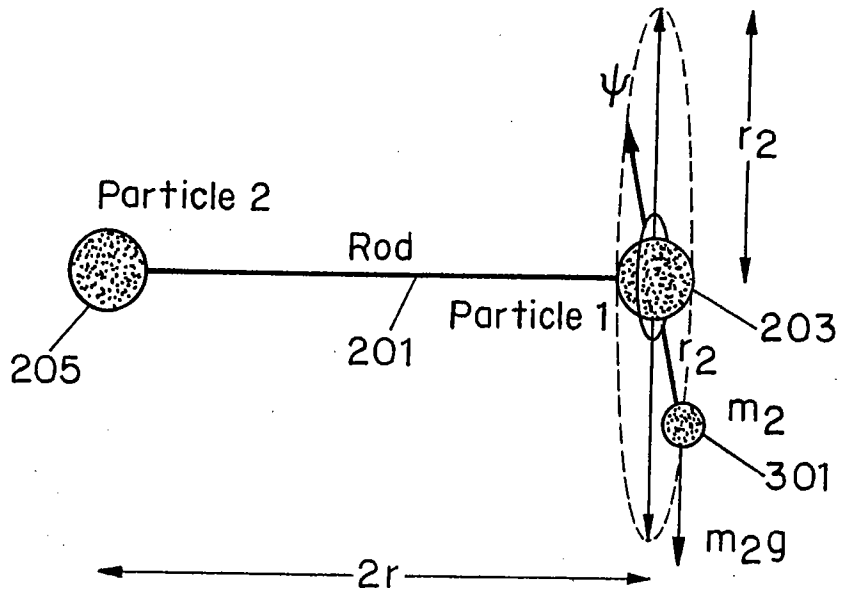
Particle 2
Rod
Particle 1
205
201
203
ψ
r2
r2
m2
301
m2g
2r

FIG. 3

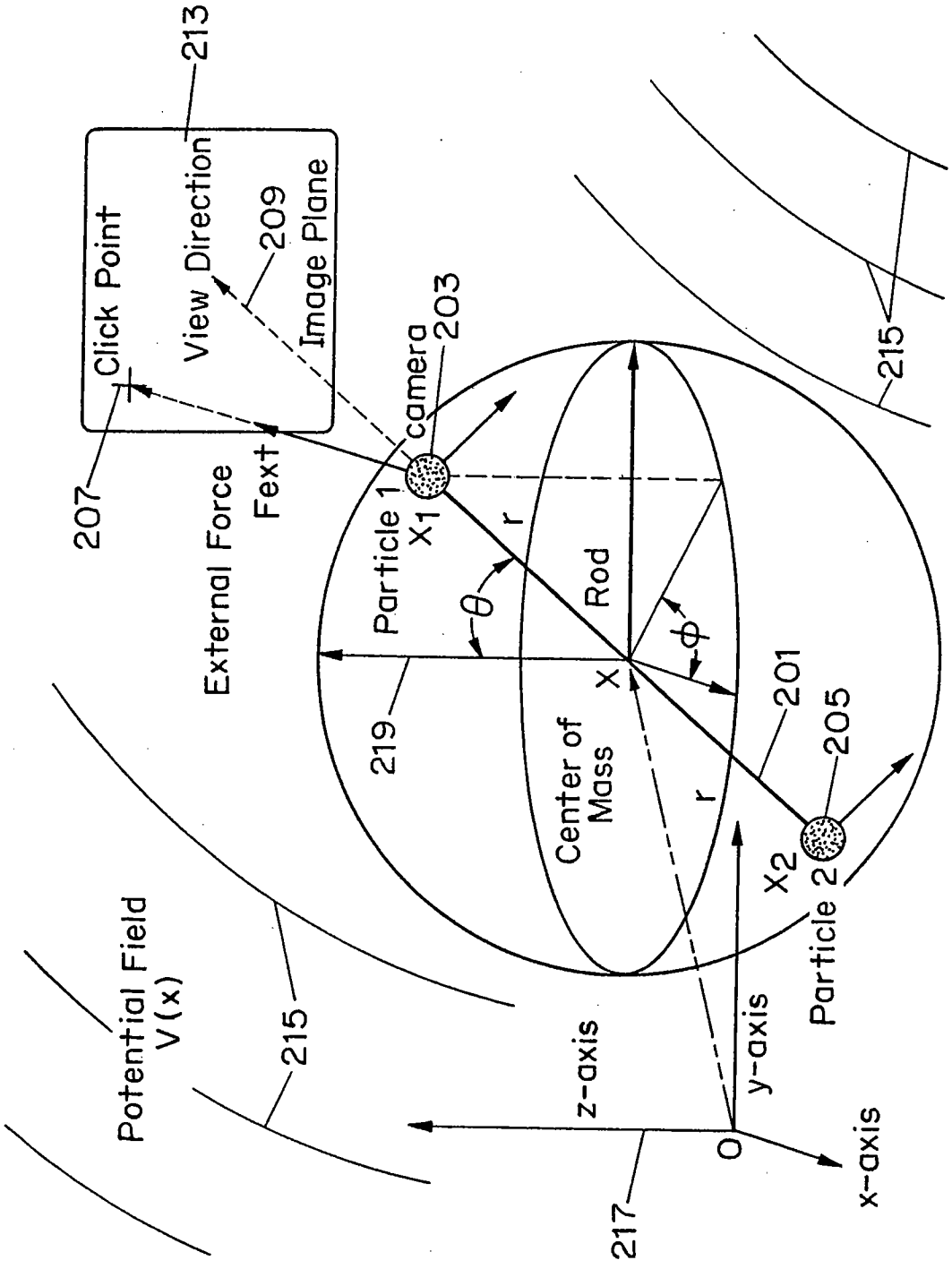
Click Point
213
View Direction
209
Image Plane
207
External Force
Fext
camera
203
Particle 1
X1
r
θ
Rod
φ
X
Center of
Mass
r
X2
Particle 2
205
201
219
215
215
Potential Field
V(x)
z-axis
y-axis
x-axis
O
217

FIG. 2

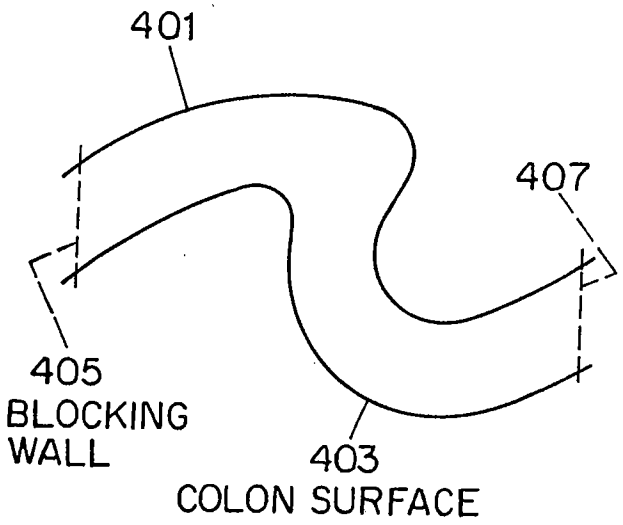

FIG. 4

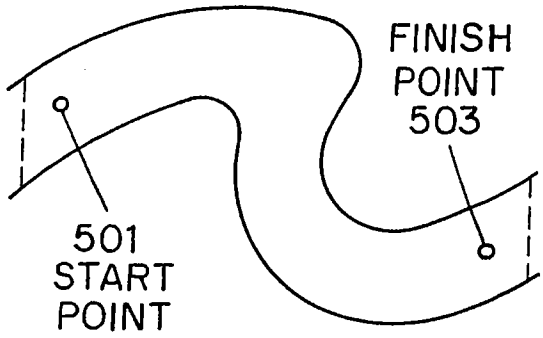

FIG. 5

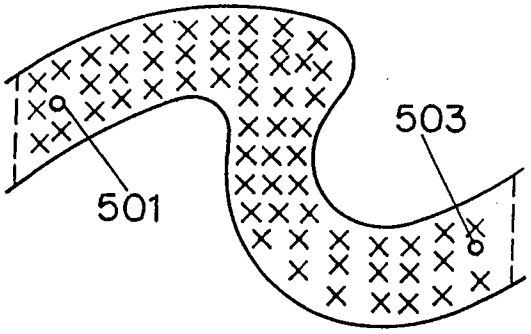

FIG. 6

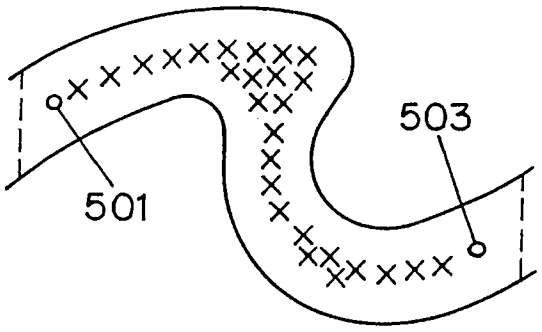

FIG. 7

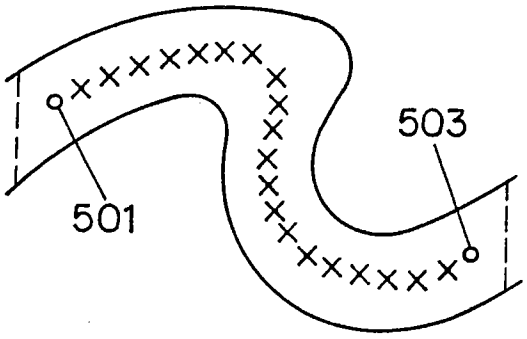

FIG. 8

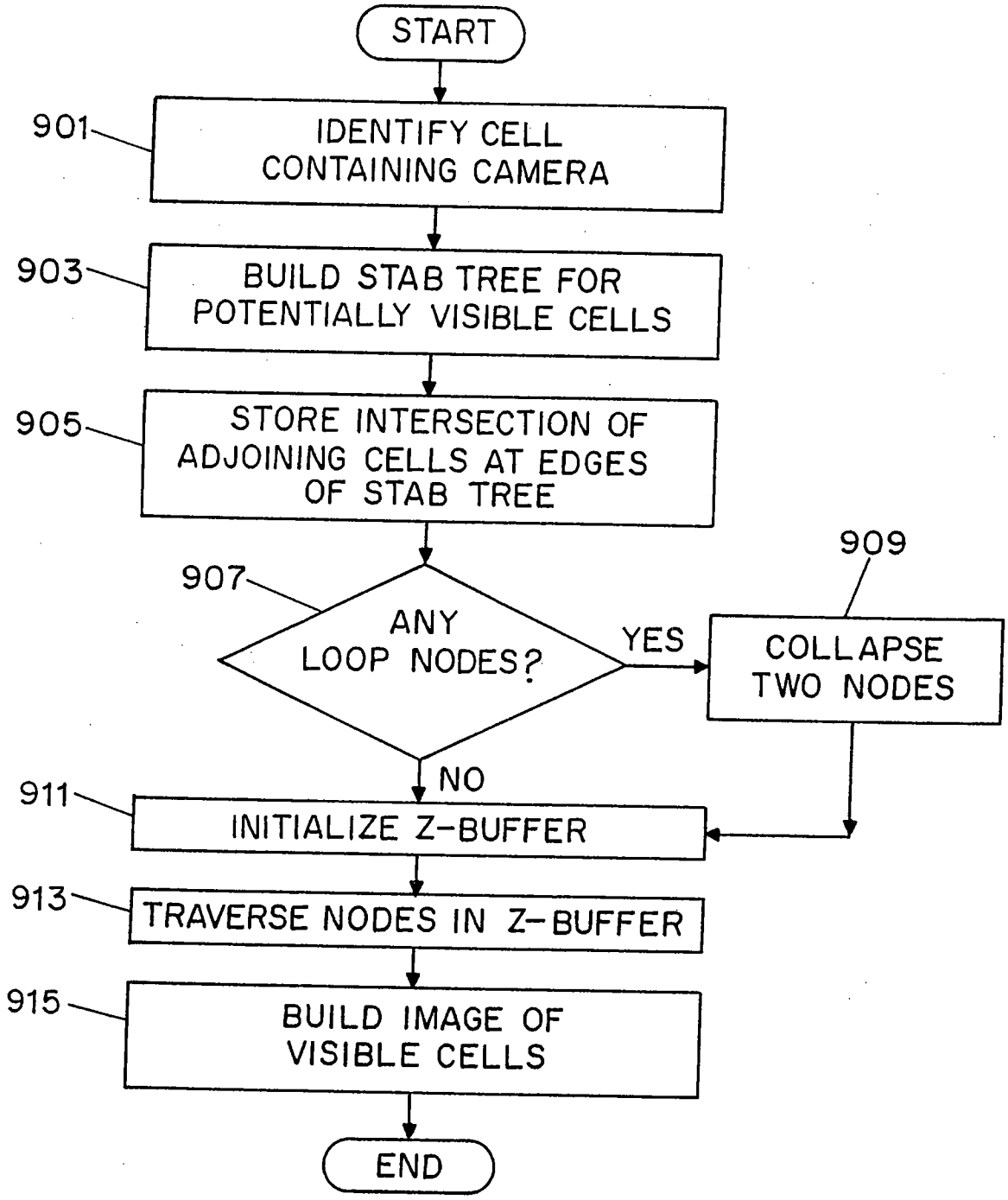
START
901
IDENTIFY CELL CONTAINING CAMERA
903
BUILD STAB TREE FOR POTENTIALLY VISIBLE CELLS
905
STORE INTERSECTION OF ADJOINING CELLS AT EDGES OF STAB TREE
907
ANY LOOP NODES?
YES
909
COLLAPSE TWO NODES
NO
911
INITIALIZE Z-BUFFER
913
TRAVERSE NODES IN Z-BUFFER
915
BUILD IMAGE OF VISIBLE CELLS
END

FIG. 9

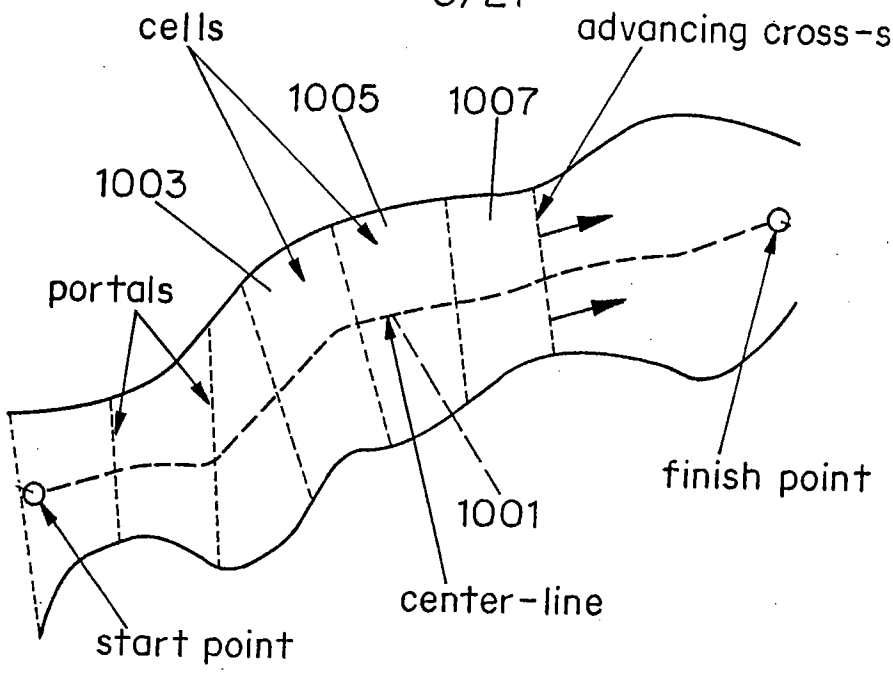

FIG. 10

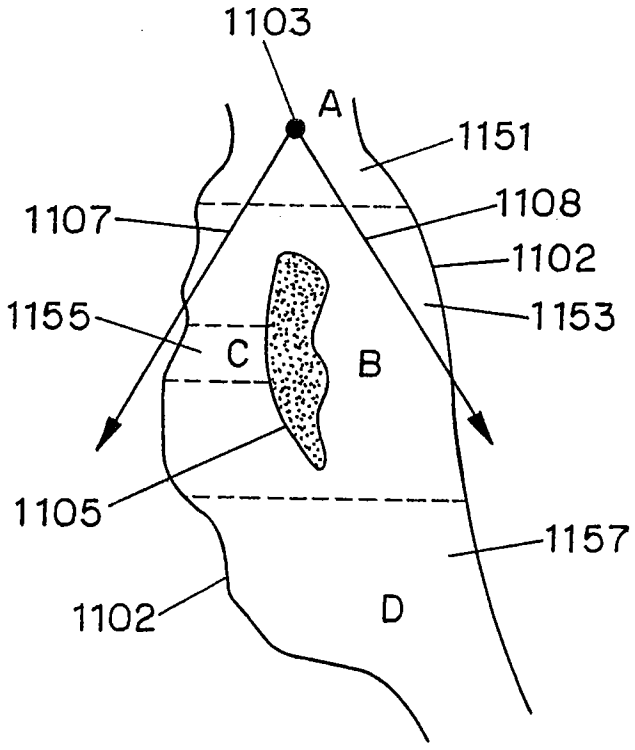

FIG. 11(a)

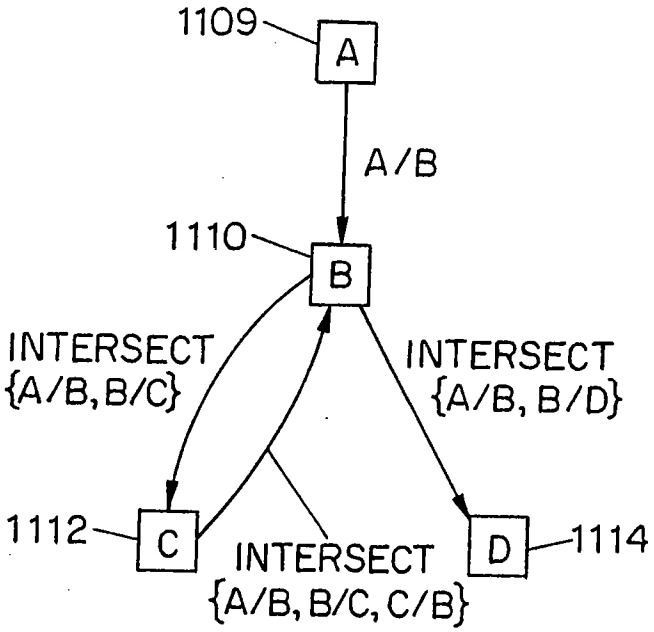

FIG. 11(b)

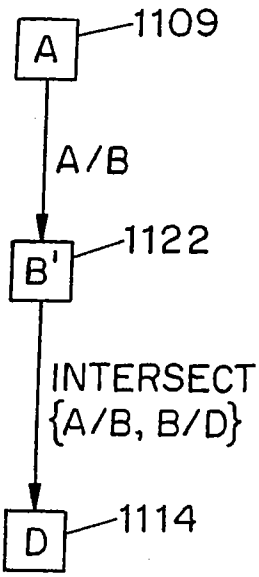

FIG. 11(c)

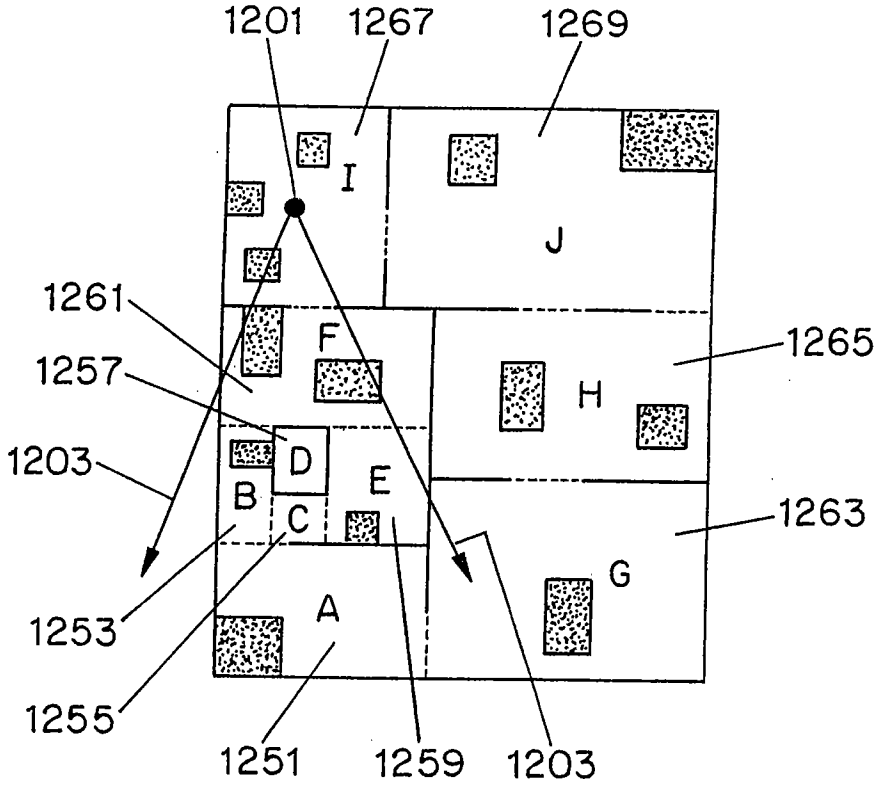

FIG. 12(a)

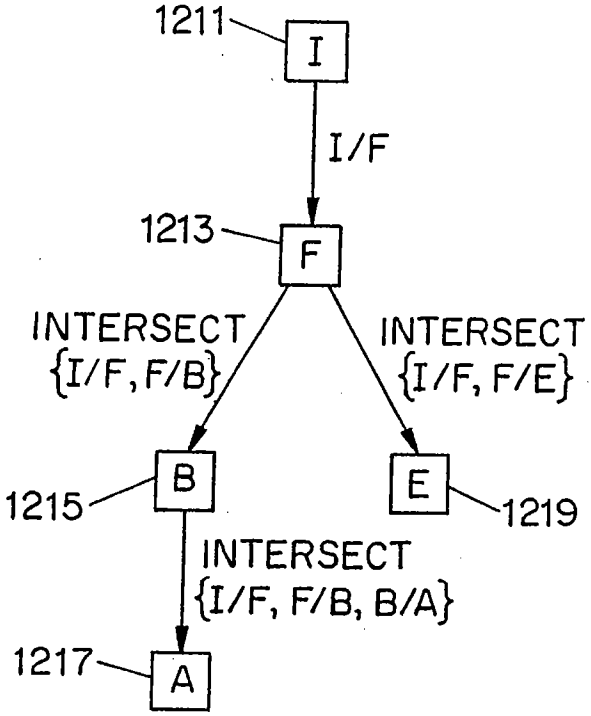

FIG. 12(b)

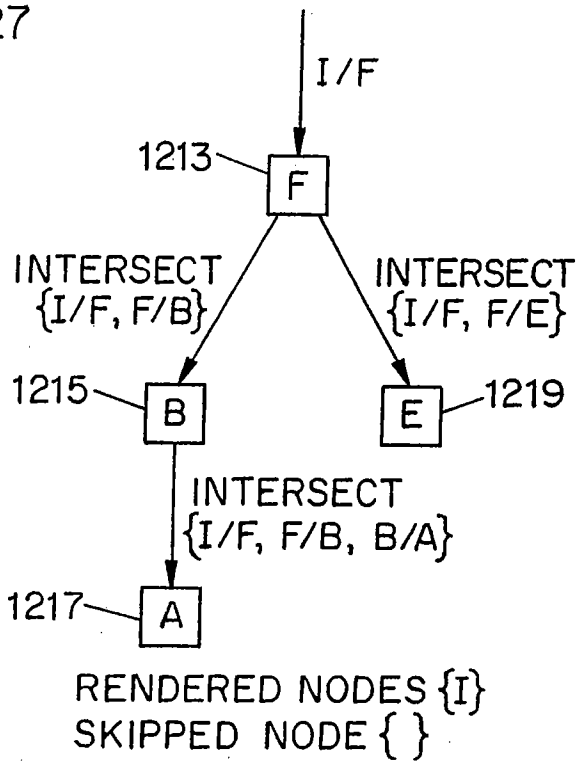

FIG. 12(c)

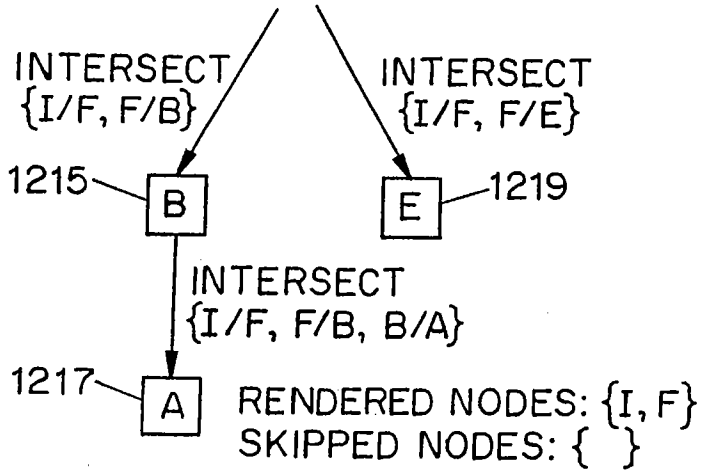

FIG. 12(d)

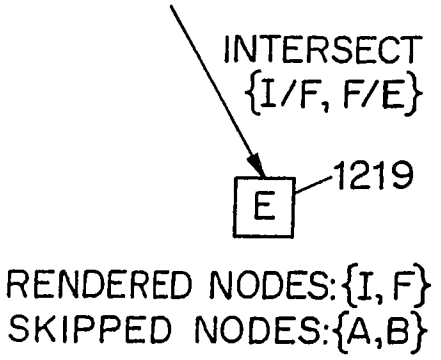

FIG. 12(e)

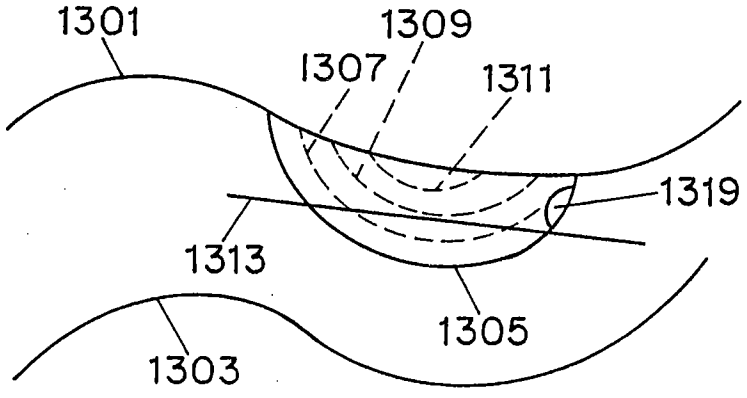

FIG. 13

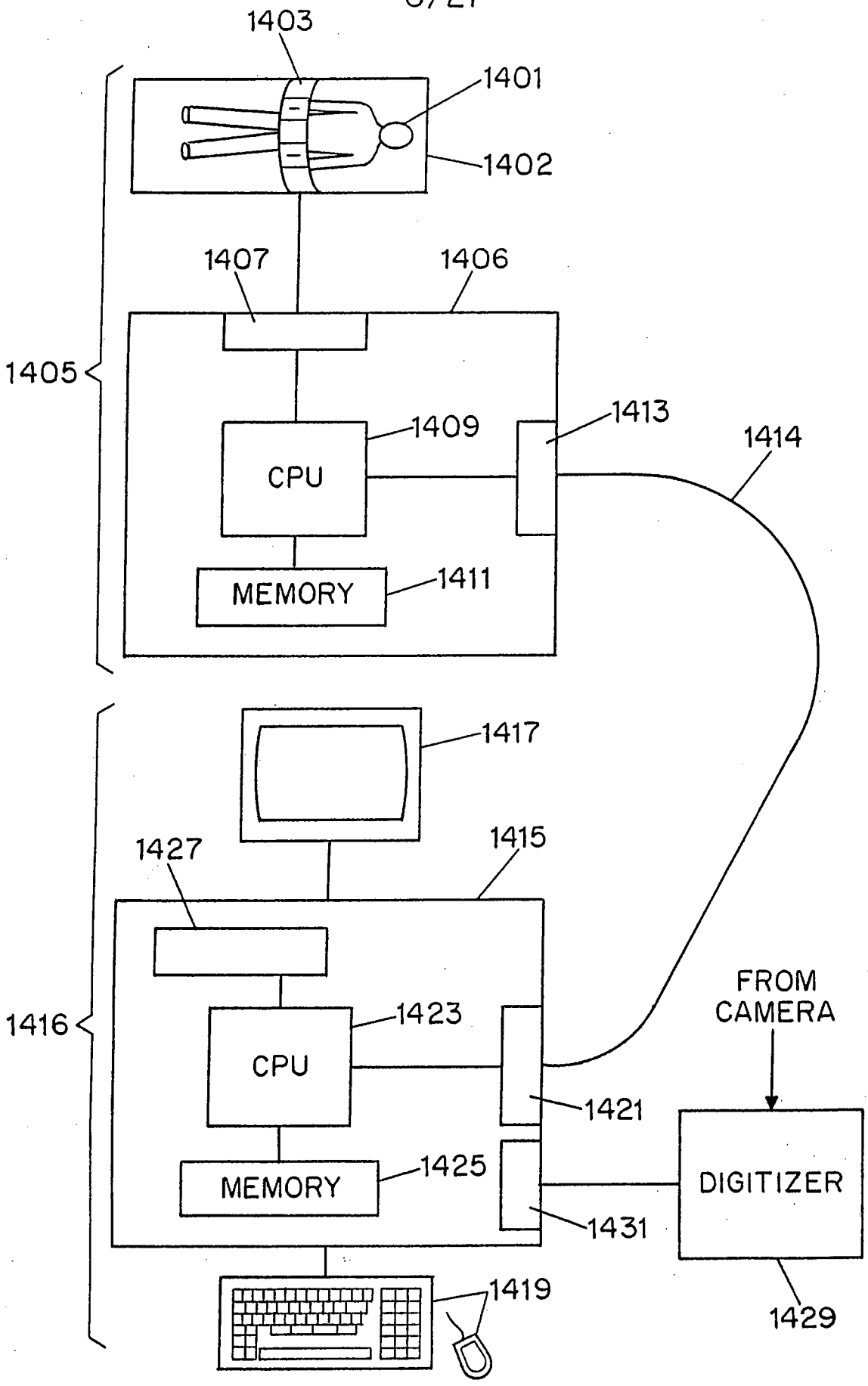
1403
1401
1402
1407
1406
1405
CPU
1409
1413
1414
MEMORY
1411
1417
1427
1415
1416
CPU
1423
FROM
CAMERA
1421
MEMORY
1425
DIGITIZER
1431
1419
1429

FIG. 14

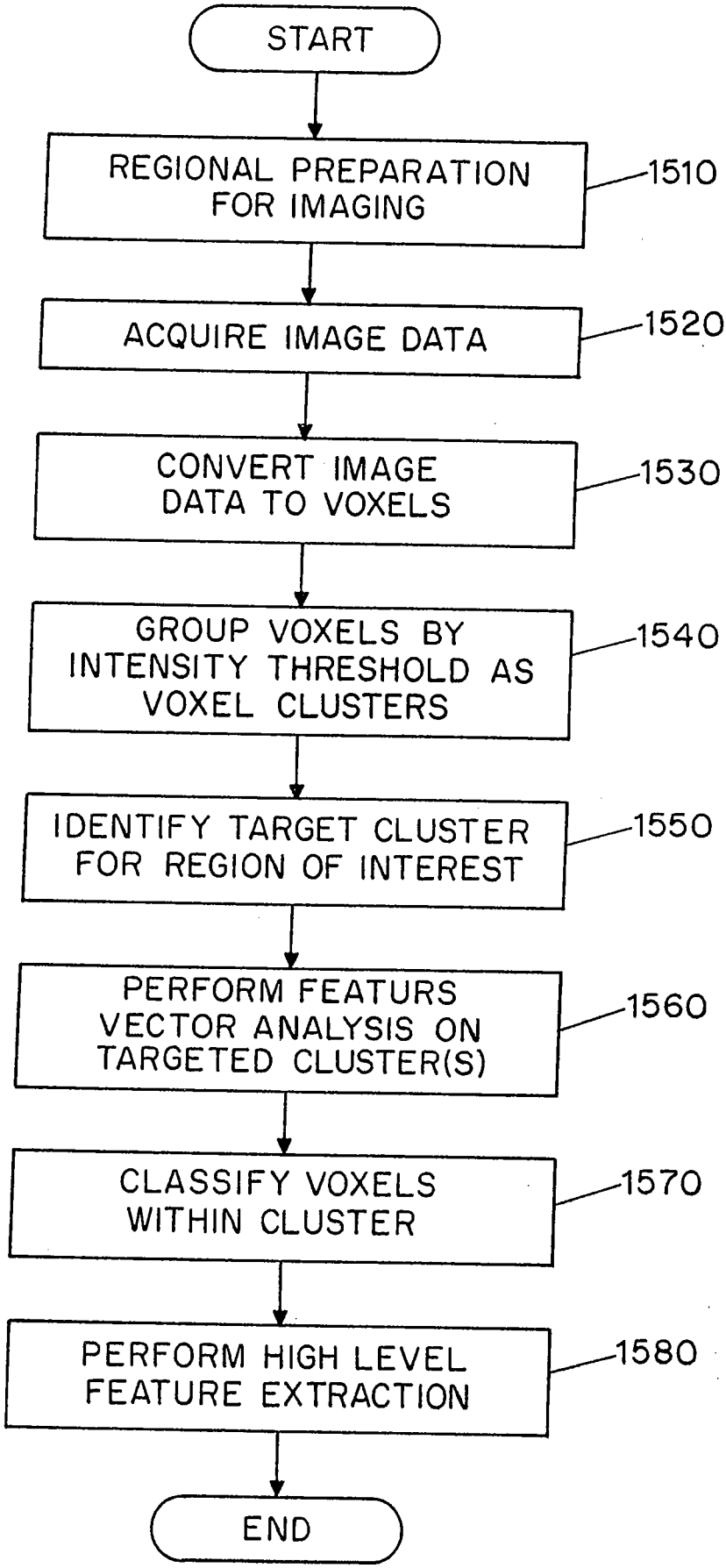
START
REGIONAL PREPARATION FOR IMAGING
1510
ACQUIRE IMAGE DATA
1520
CONVERT IMAGE DATA TO VOXELS
1530
GROUP VOXELS BY INTENSITY THRESHOLD AS VOXEL CLUSTERS
1540
IDENTIFY TARGET CLUSTER FOR REGION OF INTEREST
1550
PERFORM FEATURS VECTOR ANALYSIS ON TARGETED CLUSTER(S)
1560
CLASSIFY VOXELS WITHIN CLUSTER
1570
PERFORM HIGH LEVEL FEATURE EXTRACTION
1580
END

FIG. 15

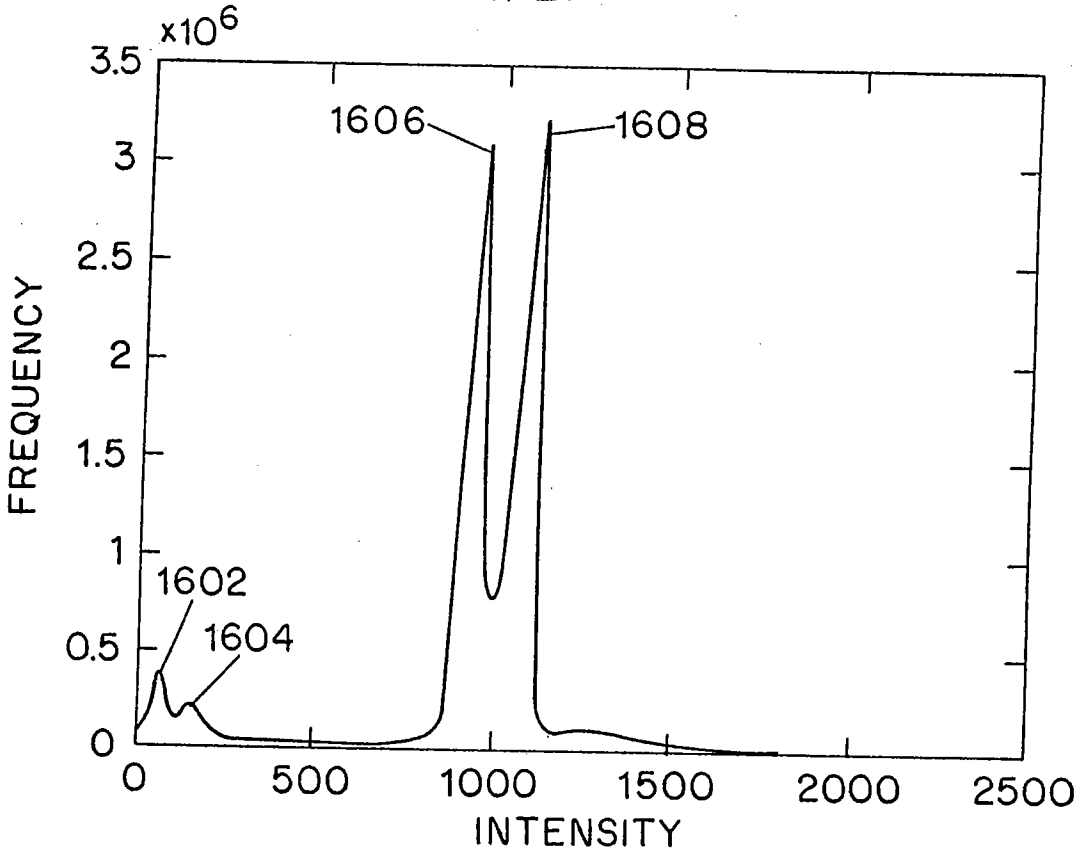
x10^6
3.5
3
2.5
2
1.5
1
0.5
0
FREQUENCY
1606
1608
1602
1604
0
500
1000
1500
2000
2500
INTENSITY

FIG. 16

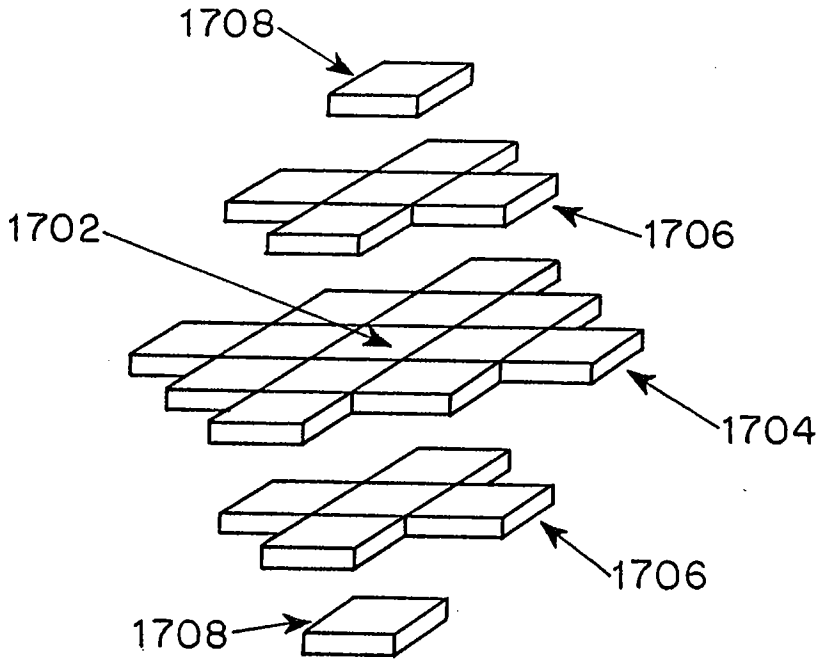
1708
1706
1702
1704
1706
1708

FIG. 17

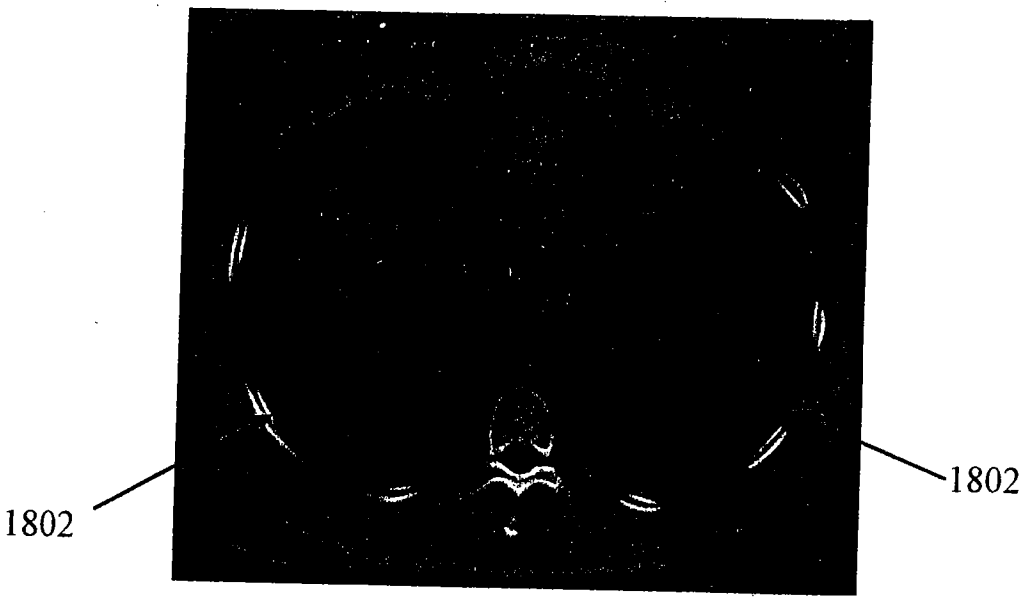

FIG. 18A

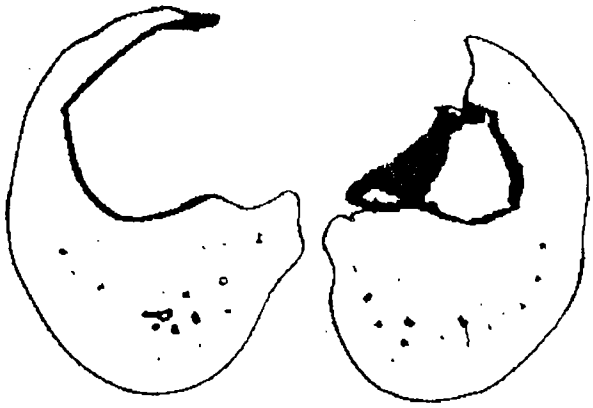

FIG. 18B

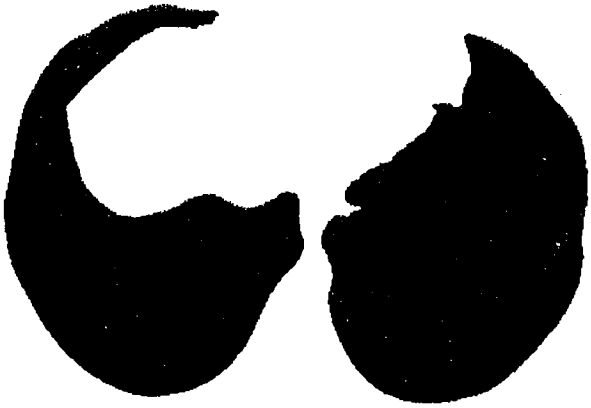

FIG. 18C

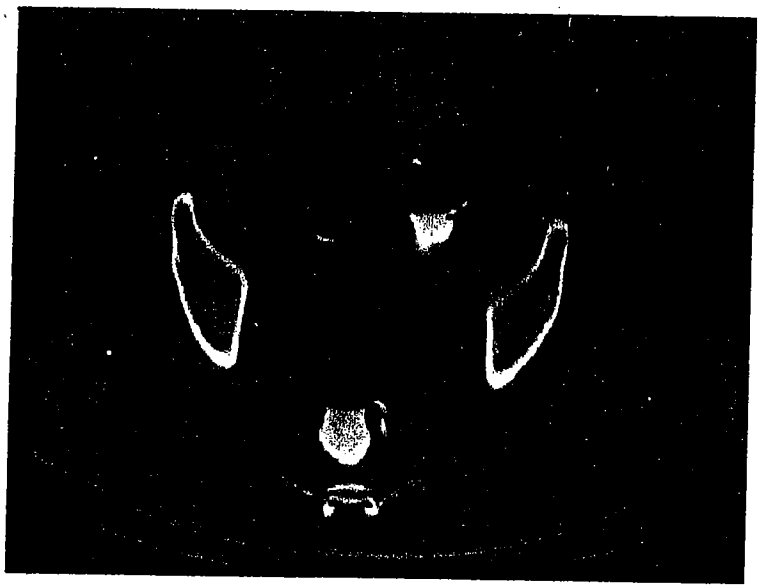

FIG. 19A

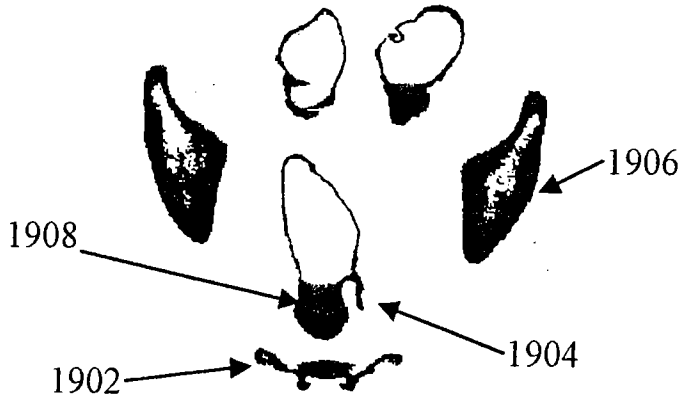

FIG. 19B

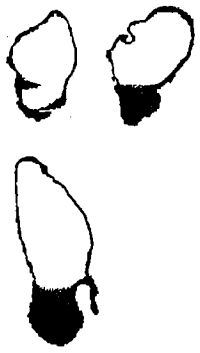

FIG. 19C

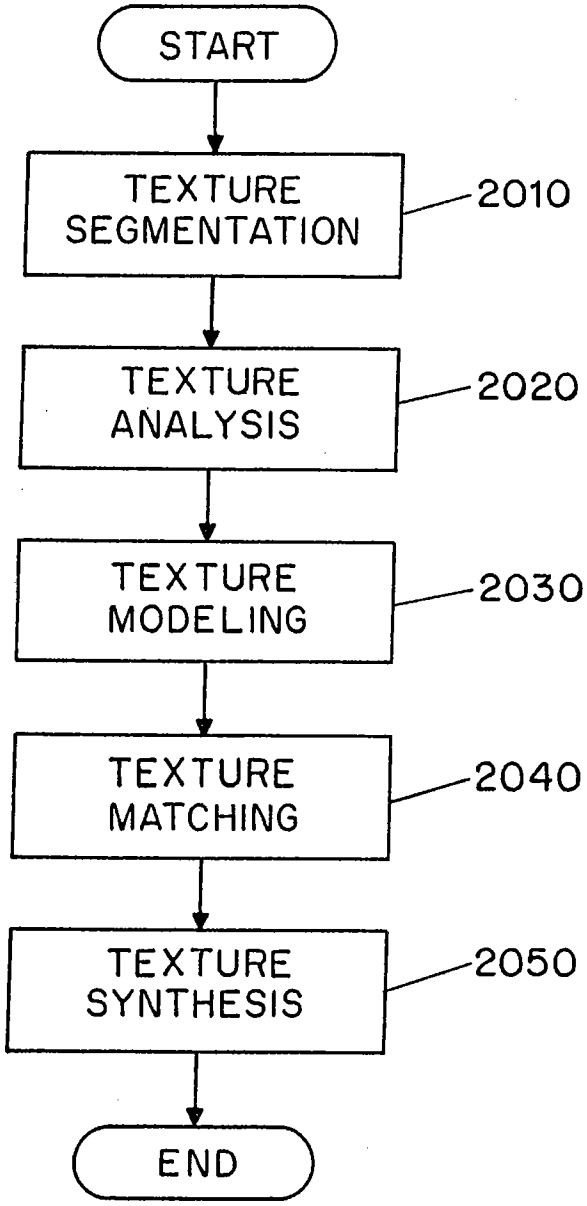
START
TEXTURE SEGMENTATION
2010
TEXTURE ANALYSIS
2020
TEXTURE MODELING
2030
TEXTURE MATCHING
2040
TEXTURE SYNTHESIS
2050
END

FIG. 20

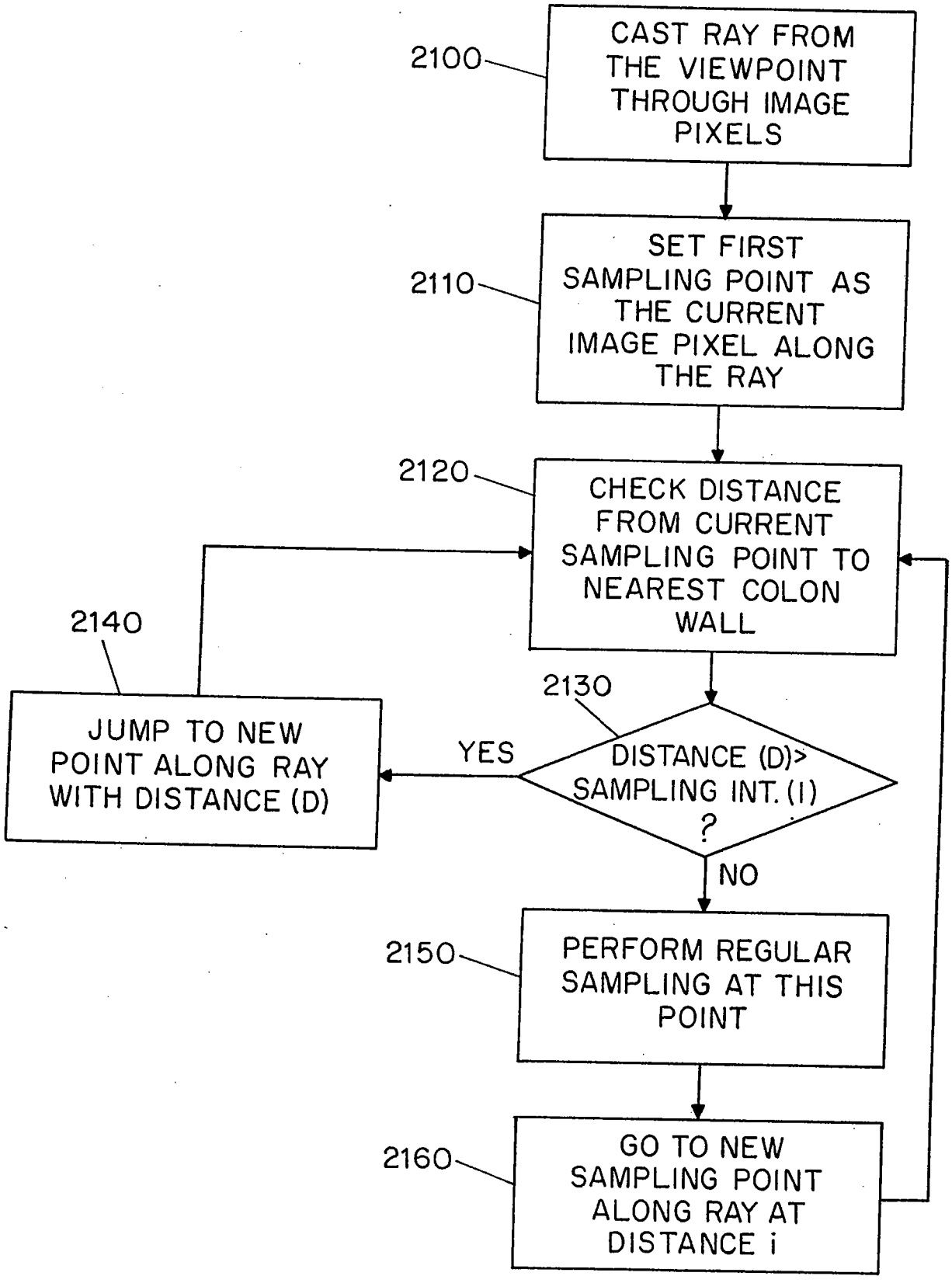
2100
CAST RAY FROM THE VIEWPOINT THROUGH IMAGE PIXELS
2110
SET FIRST SAMPLING POINT AS THE CURRENT IMAGE PIXEL ALONG THE RAY
2120
CHECK DISTANCE FROM CURRENT SAMPLING POINT TO NEAREST COLON WALL
2130
DISTANCE (D)> SAMPLING INT. (I) ?
YES
2140
JUMP TO NEW POINT ALONG RAY WITH DISTANCE (D)
NO
2150
PERFORM REGULAR SAMPLING AT THIS POINT
2160
GO TO NEW SAMPLING POINT ALONG RAY AT DISTANCE i

FIG. 21

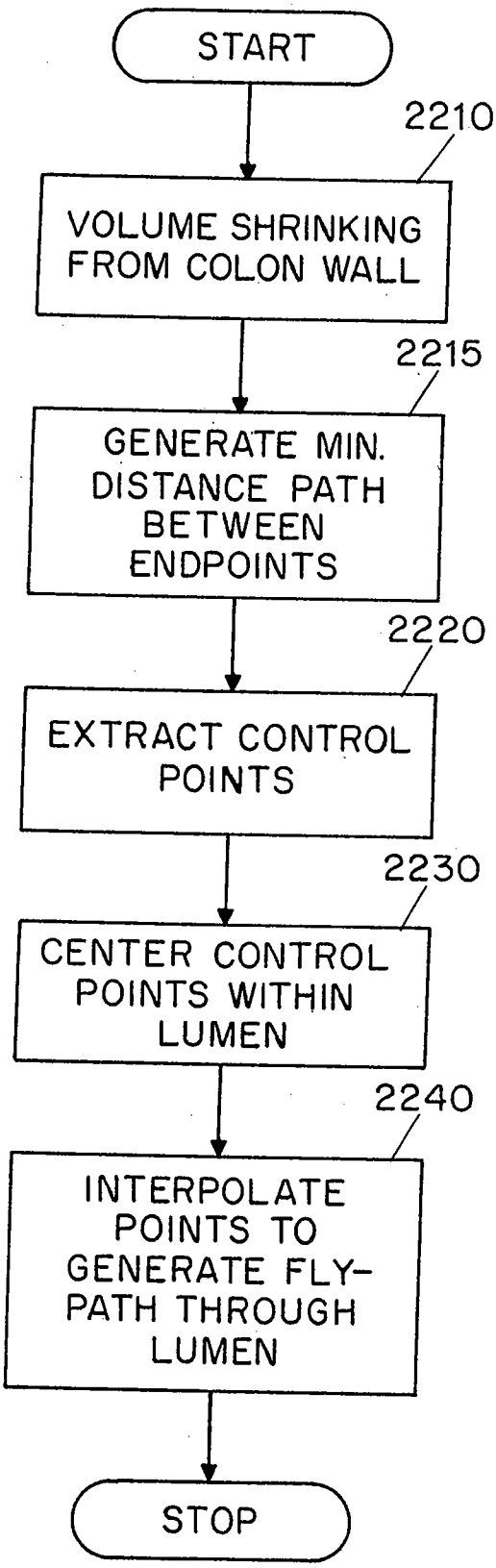
START
2210
VOLUME SHRINKING FROM COLON WALL
2215
GENERATE MIN. DISTANCE PATH BETWEEN ENDPOINTS
2220
EXTRACT CONTROL POINTS
2230
CENTER CONTROL POINTS WITHIN LUMEN
2240
INTERPOLATE POINTS TO GENERATE FLY-PATH THROUGH LUMEN
STOP

FIG. 22

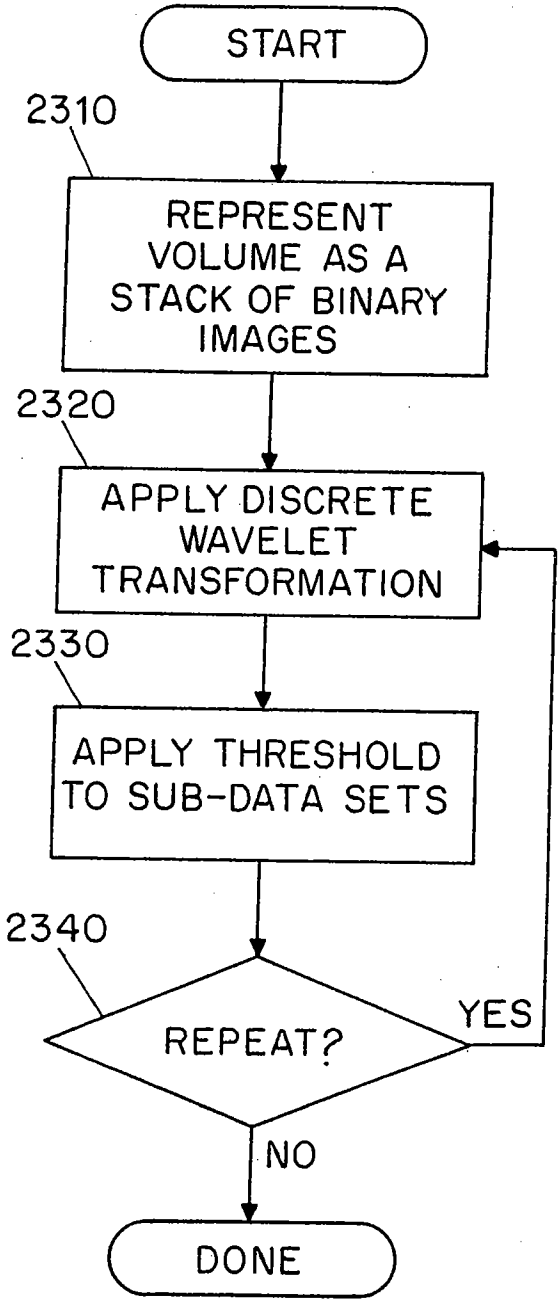
START
2310
REPRESENT VOLUME AS A STACK OF BINARY IMAGES
2320
APPLY DISCRETE WAVELET TRANSFORMATION
2330
APPLY THRESHOLD TO SUB-DATA SETS
2340
REPEAT?
YES
NO
DONE

FIG. 23

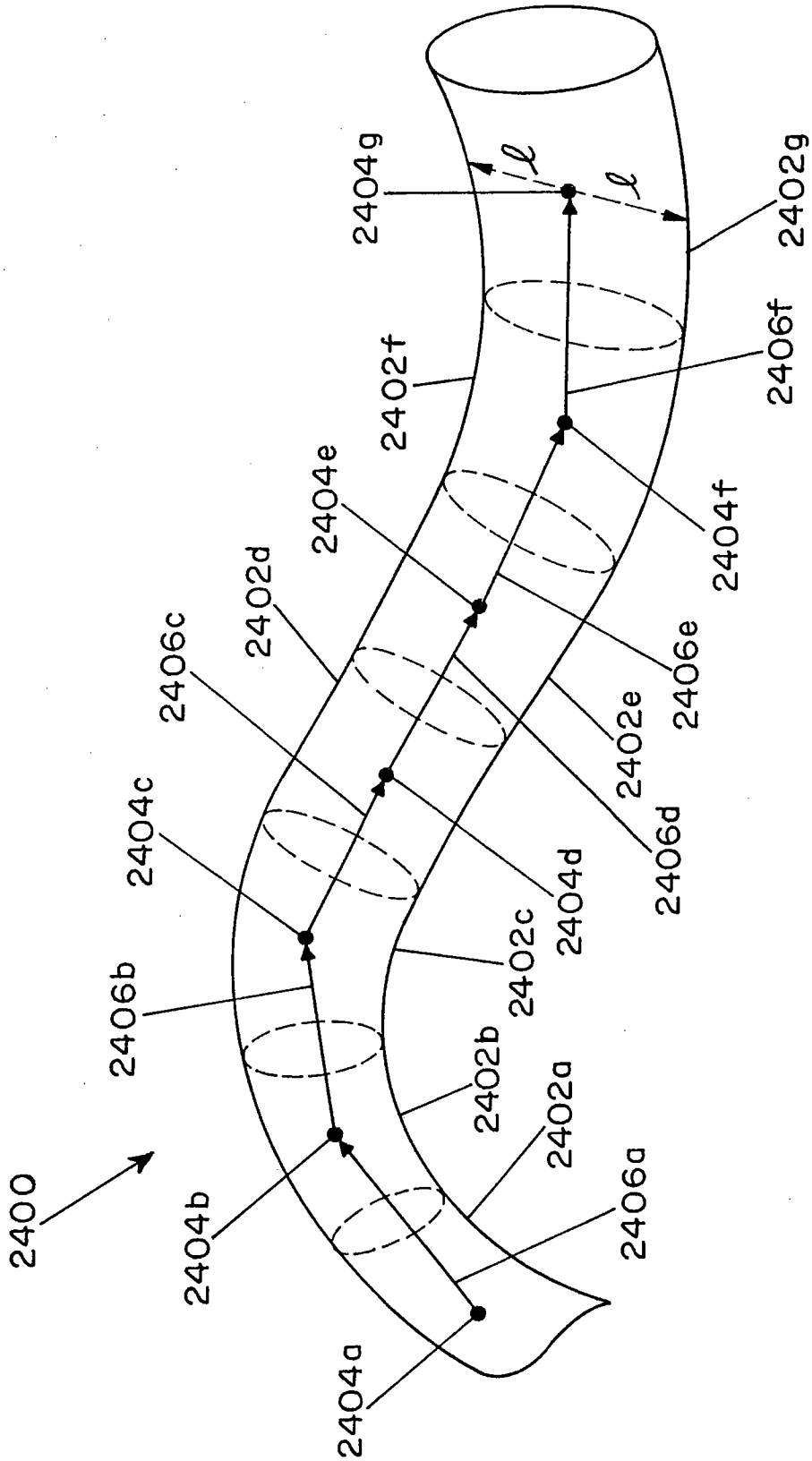
2400
2404a
2404b
2404c
2404d
2404e
2404f
2404g
2406a
2406b
2406c
2406d
2406e
2406f
2402a
2402b
2402c
2402d
2402e
2402f
2402g
ℓ
ℓ

FIG. 24

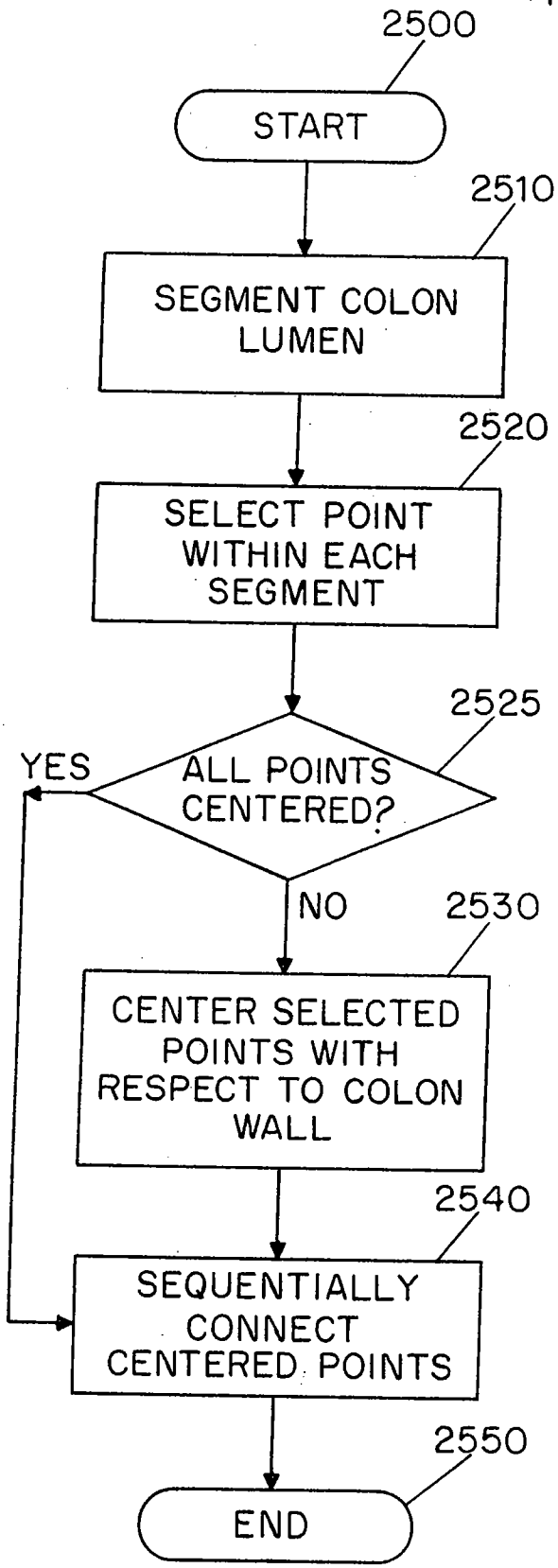
2500
START
2510
SEGMENT COLON LUMEN
2520
SELECT POINT WITHIN EACH SEGMENT
2525
ALL POINTS CENTERED?
YES
NO
2530
CENTER SELECTED POINTS WITH RESPECT TO COLON WALL
2540
SEQUENTIALLY CONNECT CENTERED POINTS
2550
END

FIG. 25

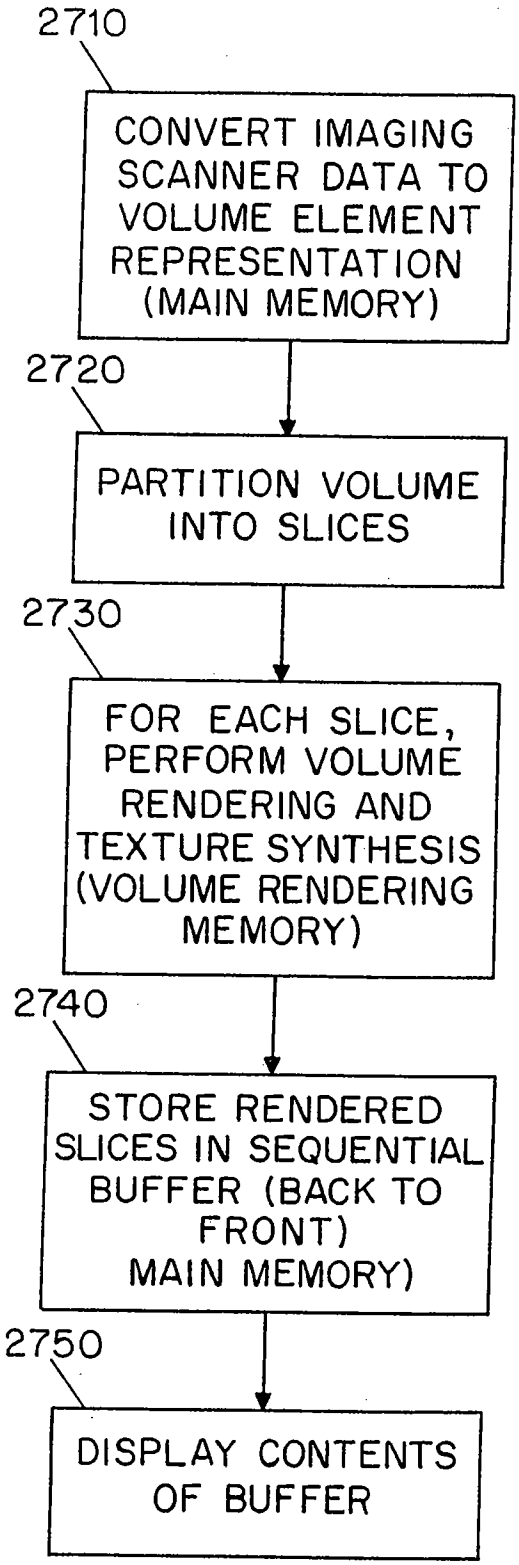
2710
CONVERT IMAGING SCANNER DATA TO VOLUME ELEMENT REPRESENTATION (MAIN MEMORY)
2720
PARTITION VOLUME INTO SLICES
2730
FOR EACH SLICE, PERFORM VOLUME RENDERING AND TEXTURE SYNTHESIS (VOLUME RENDERING MEMORY)
2740
STORE RENDERED SLICES IN SEQUENTIAL BUFFER (BACK TO FRONT) MAIN MEMORY)
2750
DISPLAY CONTENTS OF BUFFER

FIG. 27

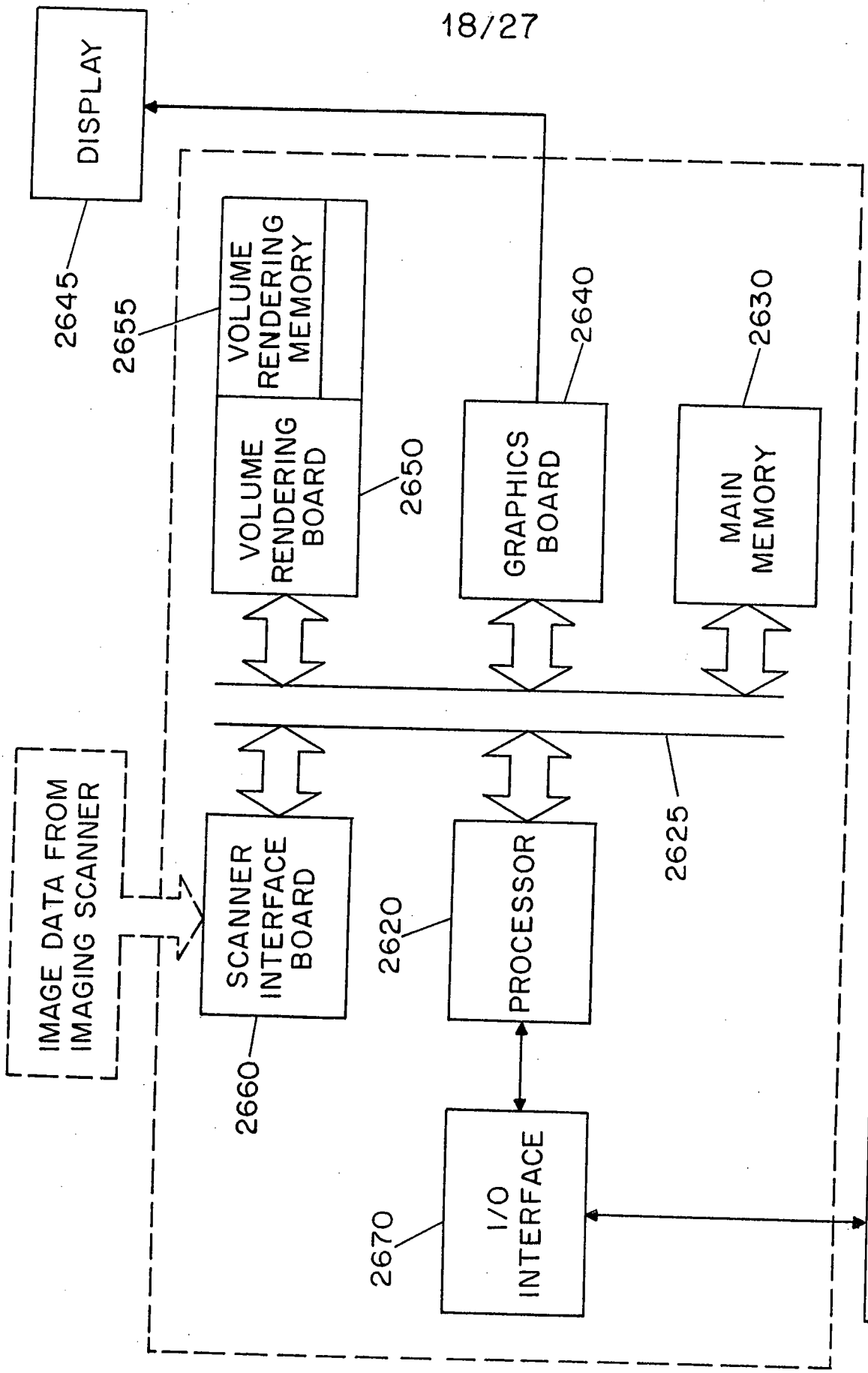
DISPLAY
2645
2655
VOLUME RENDERING MEMORY
VOLUME RENDERING BOARD
2650
GRAPHICS BOARD
2640
MAIN MEMORY
2630
2625
IMAGE DATA FROM IMAGING SCANNER
SCANNER INTERFACE BOARD
2660
2620
PROCESSOR
2670
I/O INTERFACE
I/O DEVICES

FIG. 26

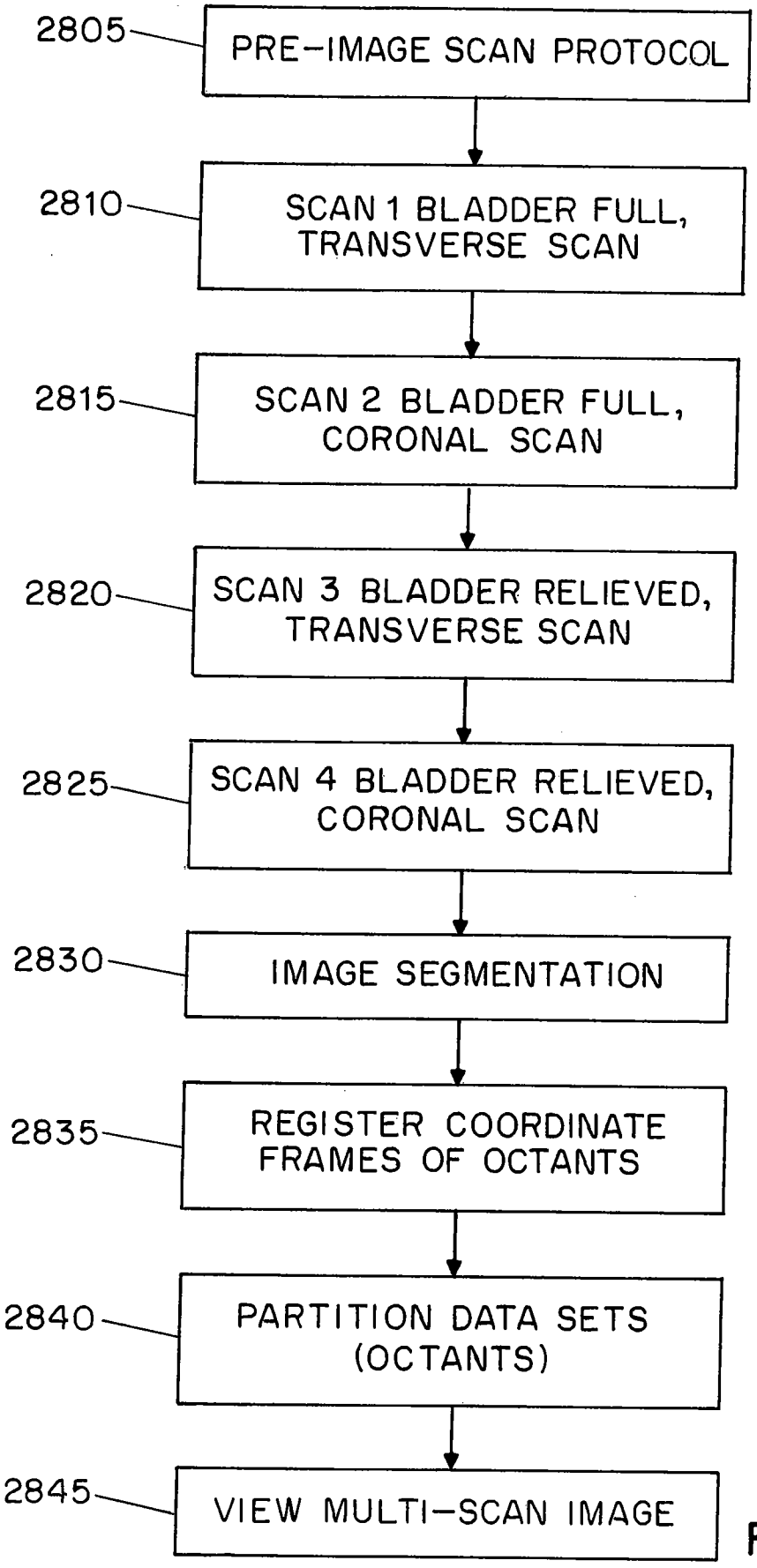
2805
PRE-IMAGE SCAN PROTOCOL
2810
SCAN 1 BLADDER FULL, TRANSVERSE SCAN
2815
SCAN 2 BLADDER FULL, CORONAL SCAN
2820
SCAN 3 BLADDER RELIEVED, TRANSVERSE SCAN
2825
SCAN 4 BLADDER RELIEVED, CORONAL SCAN
2830
IMAGE SEGMENTATION
2835
REGISTER COORDINATE FRAMES OF OCTANTS
2840
PARTITION DATA SETS (OCTANTS)
2845
VIEW MULTI-SCAN IMAGE

FIG. 28

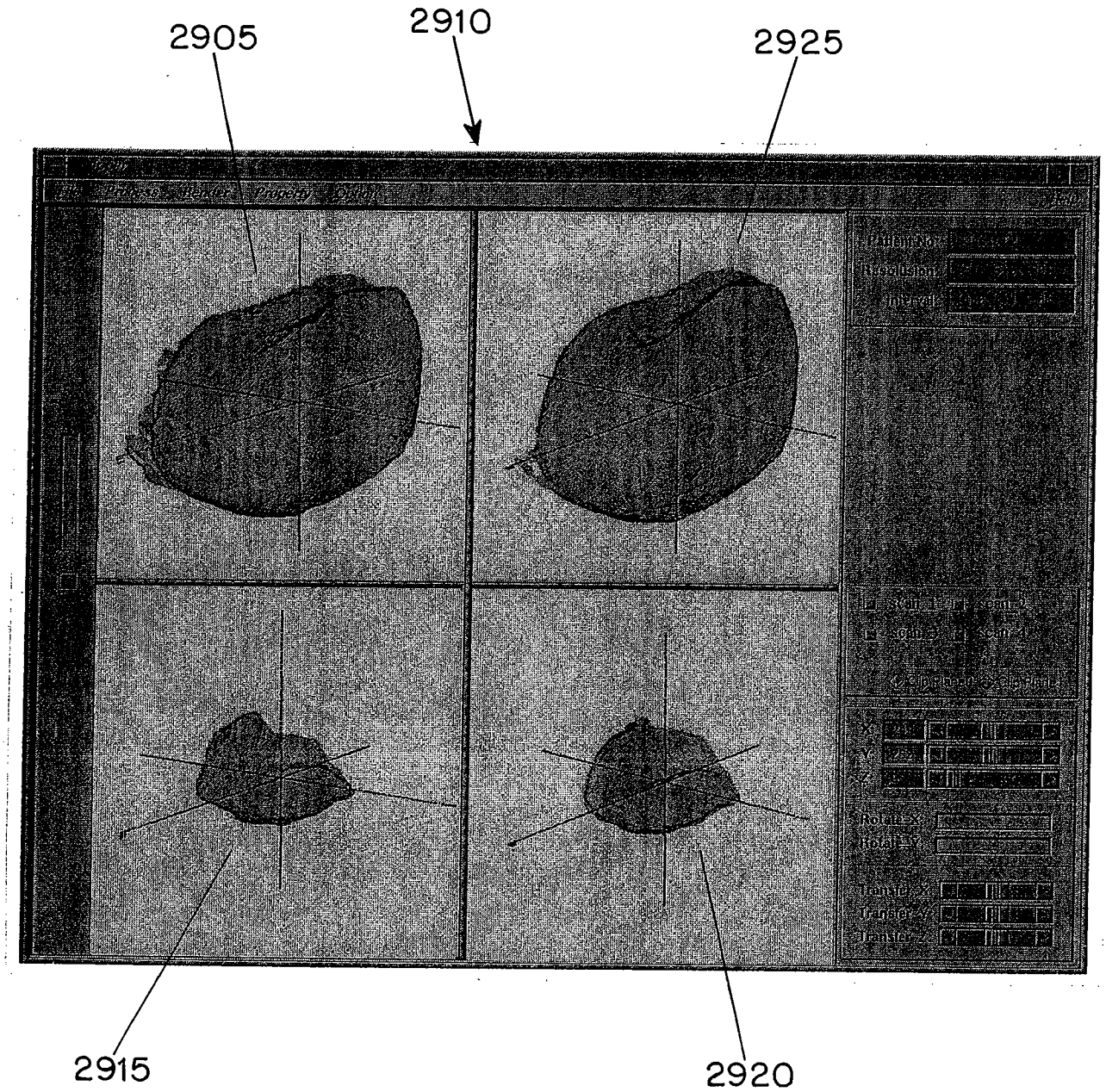

FIG. 29

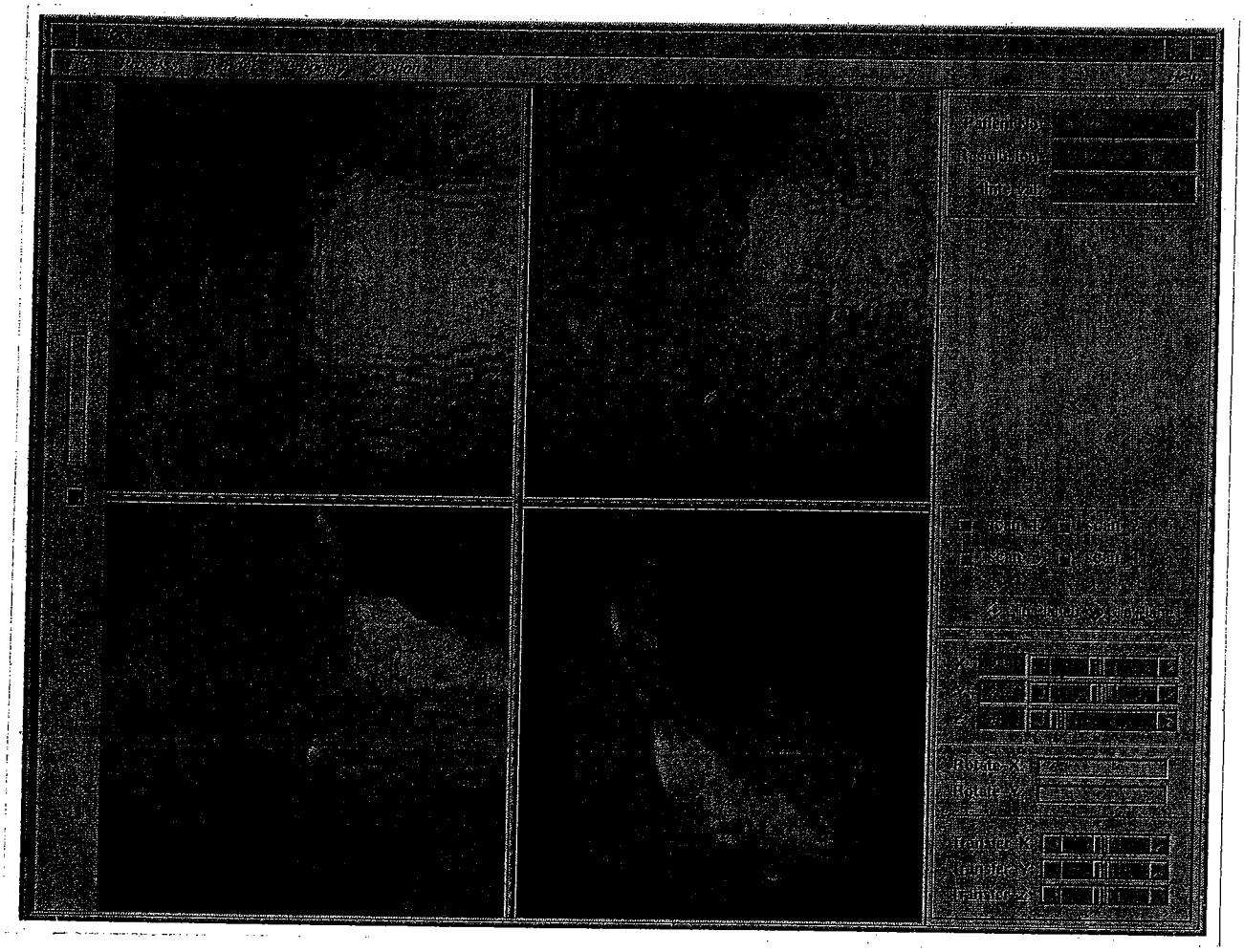

FIG. 30

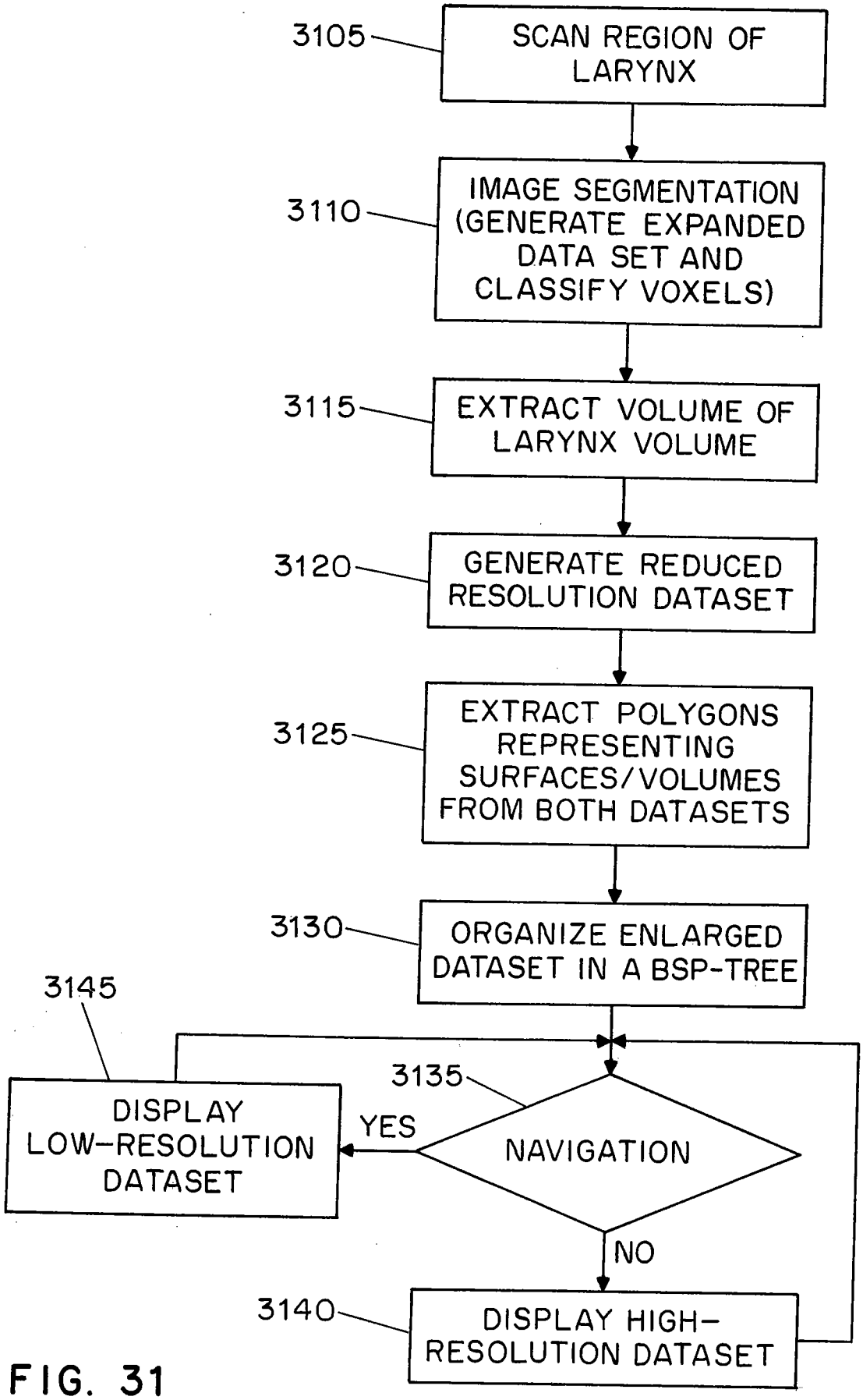
3105
SCAN REGION OF LARYNX
3110
IMAGE SEGMENTATION (GENERATE EXPANDED DATA SET AND CLASSIFY VOXELS)
3115
EXTRACT VOLUME OF LARYNX VOLUME
3120
GENERATE REDUCED RESOLUTION DATASET
3125
EXTRACT POLYGONS REPRESENTING SURFACES/VOLUMES FROM BOTH DATASETS
3130
ORGANIZE ENLARGED DATASET IN A BSP-TREE
3145
DISPLAY LOW-RESOLUTION DATASET
3135
NAVIGATION
YES
NO
3140
DISPLAY HIGH-RESOLUTION DATASET

FIG. 31

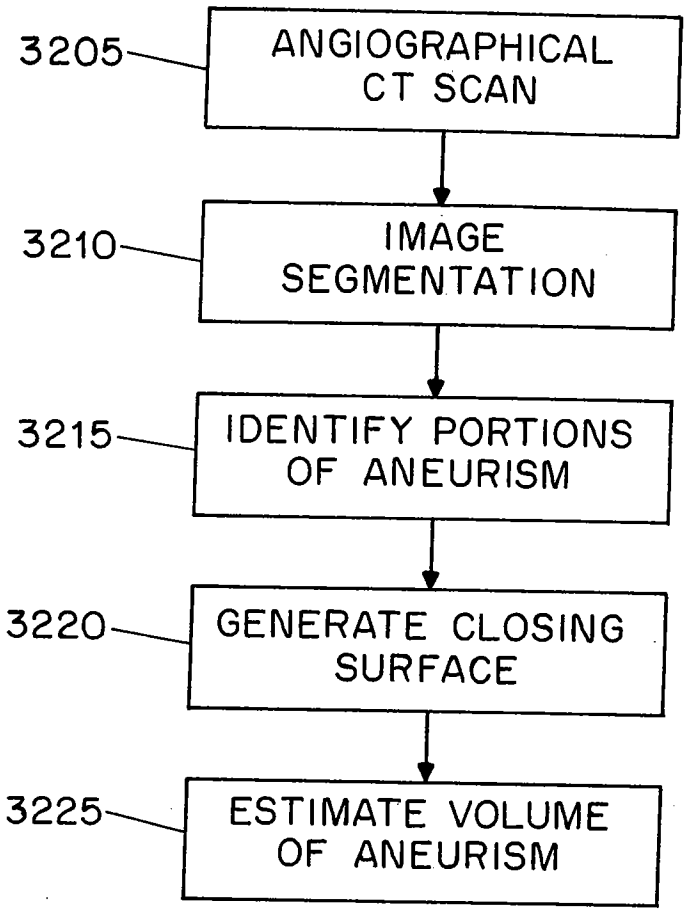
3205
ANGIOGRAPHICAL CT SCAN
3210
IMAGE SEGMENTATION
3215
IDENTIFY PORTIONS OF ANEURISM
3220
GENERATE CLOSING SURFACE
3225
ESTIMATE VOLUME OF ANEURISM

FIG. 32

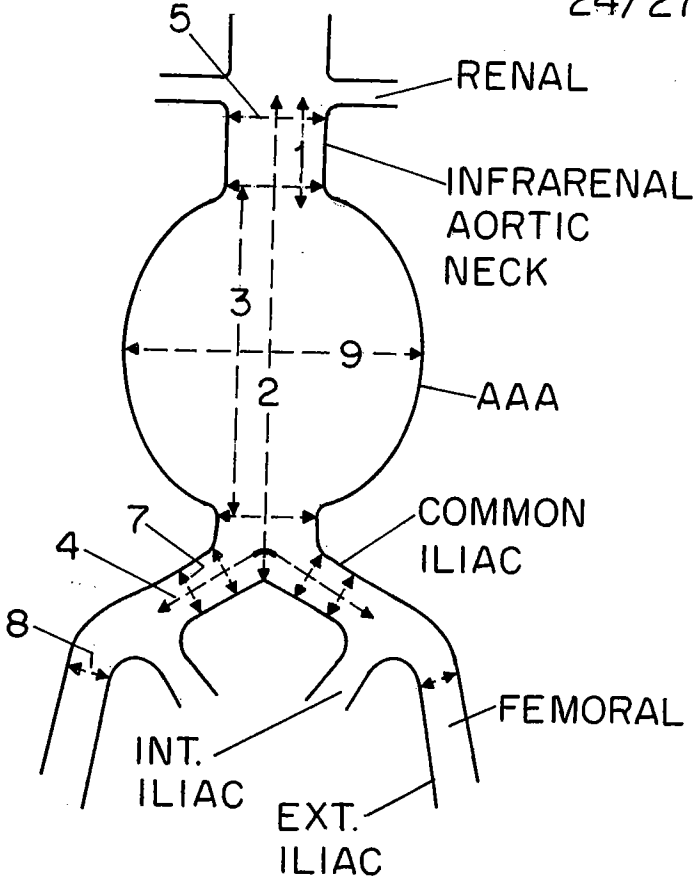

FIG. 33A

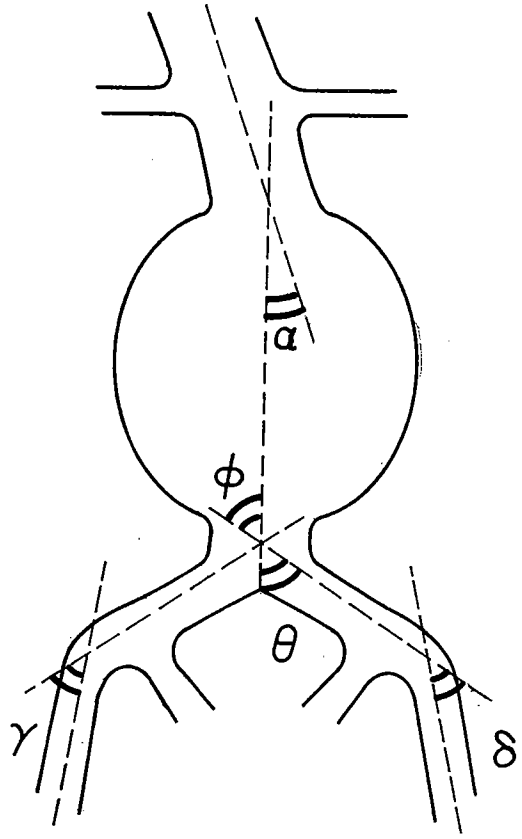

FIG. 33B

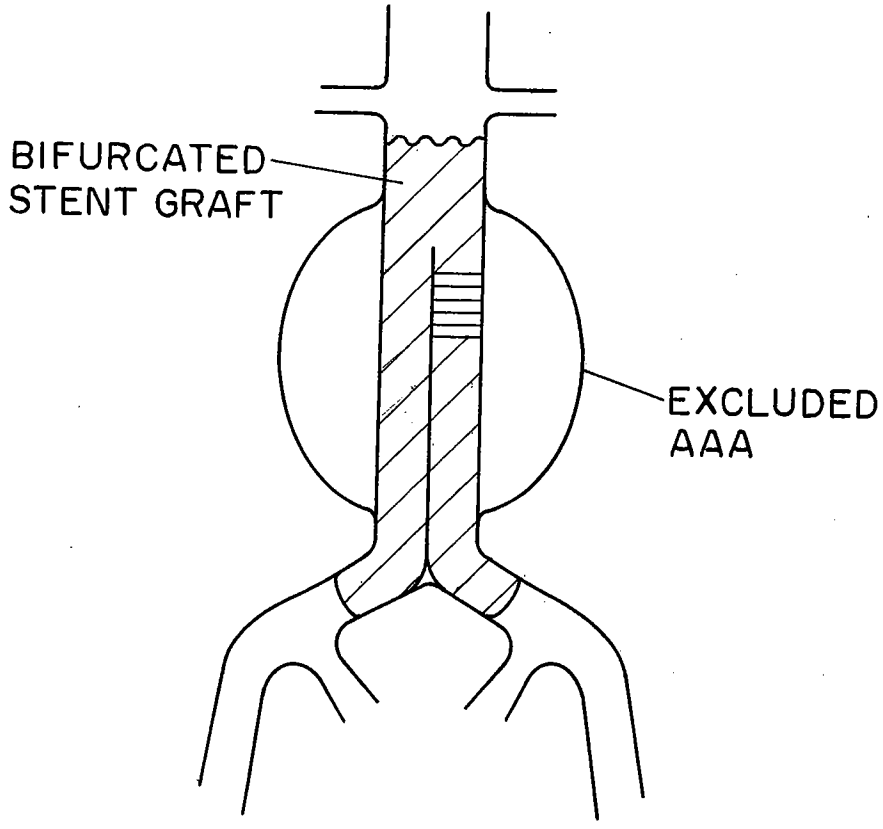

FIG. 33C

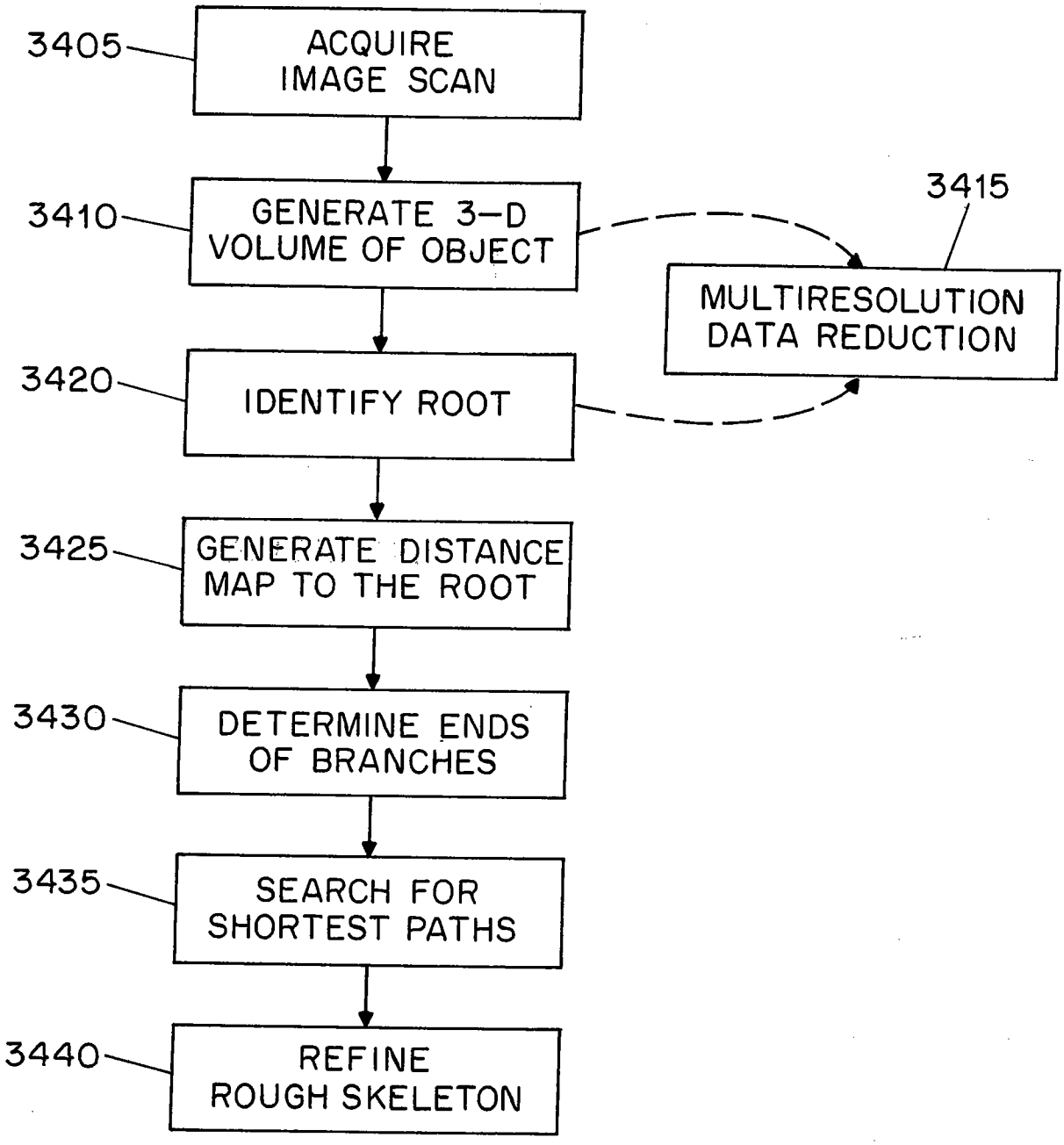
3405
ACQUIRE IMAGE SCAN
3410
GENERATE 3-D VOLUME OF OBJECT
3415
MULTIRESOLUTION DATA REDUCTION
3420
IDENTIFY ROOT
3425
GENERATE DISTANCE MAP TO THE ROOT
3430
DETERMINE ENDS OF BRANCHES
3435
SEARCH FOR SHORTEST PATHS
3440
REFINE ROUGH SKELETON

FIG. 34

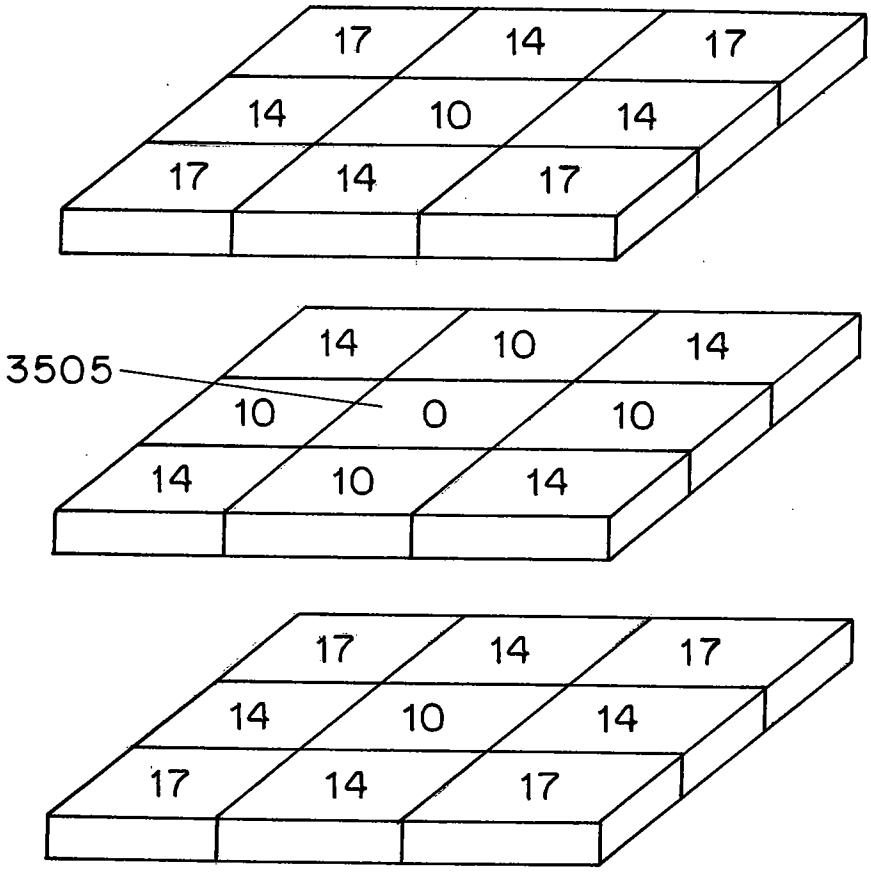
17
14
17
14
10
14
17
14
17
3505
14
10
14
10
0
10
14
10
14
17
14
17
14
10
14
17
14
17

FIG. 35

```
1) Label root voxel with integer 0;
2) Construct a queue and line up the root in the queue;
3) If (There is at least one voxel in the queue)
     Serve the voxel x on the top of the queue:
     For (each of x's 26-connected neighbor voxel y) {
       If (y in the volume and has not been labeled yet) {
         Line up the y in the queue;

         /* label the voxel y */
         Set dist = 999999;
         For (each of y's 26-connected neighbor voxel z) {
           If (z in the volume and has been already labeled with an
            integer of nz ) {

              dz ≡ nz + d (y, z);
              where d (y,z) is 10, 14 or 17 if the Euclidean distance
               between y and z is
              1, √2, or √3, respectively;
           }
           If (dist > dz ) {
              label y with integer dist;
              dist = dz ;
           }
         }
       }
     }
   }
   x leaves the quere;
 }
 Else {
    end of calculating the distance map.
 }
```

FIG. 36